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ABSTRACT

The development of a diagnostic test at the Catholic University of Chile is described. The 50-item multiple choice test is used as an ertrance and prerequisite test for students about to take a first university course in trigonometry and analytic geometry (MAT-111). Thirty items pertain to algebra and 20 to geometry. Each question corresponds to one of 50 objectives considered requisites to the course, with the focus of the test on the disclosure of pupil deficiencies. A list of the 50 objectives: infcrmation on the design, format, administration, and improvement of the test: and extensive presentations of individual item data are all included in this document. (MP)

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A REQUISITE TEST FOR A FIRST COURSE IN TRIGONOMETRY AND ANALYTIC GEOMETRY (MAT-111) AT THE CATHOLIC UNIVERSITY OF CHILE

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SUMMARY

A Requisite Test has been developed for a First University Course in Trigonometry and Analytic Geometry (MAT-111) given at the Catholic University of Chile. It is a 5-option multiple choice test with only one correct answer, with 50 items of which 30 correspond to Algebra and 20 to Geometry.

A REQUISITE TEST FOR A FIRST COURSE IN TRIGONOMETRY AND ANALYTIC GEOMETRY (MAT-111) AT THE CATHOLIC UNIVERSITY OF CHILE

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The need of educational diagnosis tests has become increasingly evident.

Generally speaking, these tests comprise a wide span of measurement activities and interpretations which help to identify the drawbacks in the students progress (Adams, 1975).

In educational systems it is common to ascribe the drawbacks of the student's progress -particularly with respect to knowledge- to deficiencies carried from previous levels.

In Universities, the high rate of failures in initial courses is frequently attributed to deficiencies originating in secondary studies. Similarly, low levels of training in terminal stages are claimed to be due to the initial courses of the curriculum. Nonetheless, the teaching staff rarely question their own performance and few of them search for the means to identify accurately the knowledge and/or skills they claim to be deficient in their students.

Diagnostic tests are the most usual means to detect the level of students who enter a course.

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Such tests aim to determine:

a) how much the students "know" about the subject of the course they will attend (entrance test).

b) their mastery of the objectives considered as requisites for a satisfactory progress in the course they are entering (prerequisite test).

The first information allows to avoid unnecessary repetitions of subject matters already learned. The second, more important, gives an insight on the true level of the students and discloses the deficiencies as to the requisites of the course. It is therefore obviously convenient to apply a diagnosis test at the beginning of each course.

For a good diagnosis, it is necessary to apply valid and reliable instruments, ensuring that the information is relevant and reflects the behavior of the students.

Such considerations have led the authors to develop and apply a Requisite Test for students entering a First Course in Trigonometry and Analytic Geometry at the Institute of Mathematics of the Catholic University, (Course MAT-111).

1. Selection of the objectives

Prior to this study, the authors had determined 129 objectives considered as requisites for the course MAT-111 (Olivares et al., 1978). To be able to apply the Test in a 2 hours period, it was necessary to reduce the number of objectives. The criterie for the selection were as follows:

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- To discard the objectives already achiaved by the students in Secondary School
- To include objectives with high levels of complexity
- To include some objectives of lesser complexity but known to be difficult for the students.

On the light of these criteria, 50 objectives were finally selected -30 in Algebra and 20 in Geometry- as follows

1. Multiply powers of like exponent
2. Solve exponential equation by equating the bases
3. Calculate the numerical value of a power
4. Define a root
5. Transform a root into a power
6. Rationalize the denominator of a fraction
7. Expand the square of a binomial
8. Expand the square of a trinomial
9. Multiply a sum by its difference
10. Add fractions
11. Simplify fractions
12. Reduce mixed fractions to simple fractions
13. Find the sign of a fraction
14. Subtract fractions
15. Factor the difference of cubes
16. Factor the difference of squares
17. Factor a trinomial of the 2nd degree
18. Remove parentheses
19. Calculate percentages
20. Perform operations with decimals
21. Perform substitutions
22. Solve equations of the first degree

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23. Solve equations of the second degree
24. Analyze the nature of the product of equations of the 2nd degree
25. Solve a system of 2 equations of the first degree in 2 unknowns
26. Solve a system of 2 equations of the second degree in 2 unknowns
27. Solve problems with a statement
28. Propose the equation that will allow to solve a problem
29. Express sentences in mathematical language
30. Given a certain ratio, calculate a related one
31. Define the synmetral of a line
32. Define the singular points of a triangle
33. Apply the theorem relating to the ratio given by the intersection point of the medians of a triangle
34. Apply the theorems of Pythagoras and Euclid
35. Apply the theorem of Pythagoras
36. Identify similar triangles
37. Apply the theorem of Thales
38. Apply the theorem of Euclid
39. Recognize parallelograms in a figure
40. Apply theorems on parallelograms
41. Add and subtract given angles in degrees, minutes and seconds
42. Calculate the area of plane figures
43. Solve problems on plane figure areas
44. Define the circumference
45. Analyze relative positions between two circumferences
46. Define the number

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47. Apply the relation between the inscribed angle and the central angle which subtend the same arc of a circum ference
48. Count faces, edges and vertices of a polyhedron
49 Calculate the volumen of a polyhedron
50. Recognize when planes or lines are parallel or perpendicular

Design of the Test

Multiple choice items were worked out for each of the objectives selected, comprising five options of which only one was the correct answer. The items were submitted to specialists for their evaluation and selection. Whenever two or more items were considered valid by these referees the teaching staff selected one in accordance to their previous experience with the students.

Format of the Test

The Test is presented in a booklet consisting of: (a) an instruction sheet; (b) 50 items, 30 in algebra and 20 in geometry; and (c) a separate Answer Sheet.

Administration and Improvement of the Test

The Test was applied in two instances (1977 and 1978) to the students of the Course MAT-111. These trials were administered along a two hour period.

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Analysis of data was done considering the responses of students who had entered the University on the same year of the application of the test. Care was taken to avoid contamination of the results derived from responses given by students having some experience in the Course.

These results allowed to determine the reliability, degree of adequacy and biserial correlation coefficient of the Test.

In 1977 the Test was administered to 538 students who had entered the University that same year. In that occasion, the reliability of the Test was measured according to Kuder-Richardson 21. The correlation coefficient obtained was 0.73 ($p < 0.01$) (Rojas et al., 1977).

Some of the items gave a negative index in their degree of difficulty (Rojas et al., 1977).

Although the Test had been found to have an acceptable index of reliability, it was deemed necessary to modify some of the items in order to further improve it. The new items considered were again submitted to referees and the test was reset in a new version, with the same characteristics of the initial one. This version was applied in 1978.

Estimation of the reliability of the Test in its 1978 version

The Test was administered in 1978 to 477 students on entering the University. The reliability of the Test was calculated according to Kuder Richardson 20 and to Gulliksen. The resulting coefficients were .984 and .768, respectively ($p < 0.01$).

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Analysis of the Test per item

The biserial correlation coefficient was calculated for each item. The values obtained fluctuated between .352 and .260 (Table 1). All coefficients were significant ($p < 0.01$).

The percentage of correct answers was calculated. Unanswered questions were not considered. For the values obtaines, sea Table 2. It is worth noting that in 14 items the percentage of correct answers was below 50%. Of these only two correspond to Algebra (items 13 and 26) and the rest to Geometry.

Results obtained after analyzing omitted and incorrect responses (per distractor), are presented in Table 3. It can be seen that 10 items have a percentage of omission over 25%. Among these items, item 26 had 73.22% and item 32, 51.69% of omission. Thirteen items presented a percentage of incorrect answers under 10%. Of these, 12 correspond to Algebra and only one to Geometry. Two items show a percentage of mistakes over 50% corresponding to items 13 (Algebra) and 49 (Geometry). None of the distractors feiled to be selected by the students.

In order to determine whether the period of 2 hours allowed for the administration of the test was adequate to its length, the percentage of omitted responses per item was calculated (Table 3). It was found that the last item (N°50) was not answered by 7.05% of the students: item 49 was not answered by 5.63% and the items from 1 to 28 showed 0% of unanswered questions.

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Final Version of the Test

After having been administered, tried and optimized the requisite Test for the Course of Trigonometry and Analytic Geometry (MAT-111) was set as follows:

1. Title:

   "Requisite Test for the Course of Trigonometry and Analytic Geometry (MAT-111)"

2. Purposes:

   To detect requisites on knowledge of Algebra and Geometry for the course MAT-111. In general, as a diagnosis instrument, it allows to establish the degree of mastery in mathematic knowledge considered as a prerequisite. In particular, it yields specific information with respect to the presence or absence of specific knowledge corresponding to each of the objective-requisites for which the instrument is designed.

3. Description of the Test:

   It is an objective test consisting of a sheet of instructions, 50 items and an answer sheet.

4. Type of question:

   All items are of multiple choice with 5 options of which only one is correct. Each item is related to one objective-requisite of the Course MAT-111.

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5. Array of the items:

30 items in Algebra and 20 in Geometry.

6. Administration:

No specialized staff is required. The time of administration was established at two hours.

7. Scoring:

The test was checker by means of punched cards

8. Validity of contents:

The skills this test aims to measure are based on the objective-requisites of the course MAT-111, it must be noted that:

a) They do not pertain to the official program of the course MAT-111
b) They are included as contents in the official curriculum of Secondary School

As to the validity of the contents, the opinions of the referees were:

- The objectives pertain to the category of requisites;
- The objectives correlate well with the items;
- Stem and distractors are appropriately constructed.

9. Reliability:

It was determined according to Kuder-Richardson -20 and Gulliksen, with coefficients 0.98 and 0.77, respectively.

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10. Applicable to university students entering a first Course of Trigonometry and Analytic Geometry.

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TABLE 1

Biserial correlation coefficients obtained for each item. Requisite Test for the Course MAT-111, 1978 version.

Item	Coef. Correl.	Item	Coef. Correl.
1	0.260	26	0.352
2	0.295	27	0.274
3	0.273	28	0.298
4	0.280	29	0.306
5	0.299	30	0.298
6	0.308	31	0.280
7	0.269	32	0.310
8	0.292	33	0.295
9	0.266	34	0.266
10	0.267	35	0.333
11	0.277	36	0.272
12	0.275	37	0.289
13	0.319	38	0.299
14	0.284	39	0.273
15	0.268	40	0.289
16	0.315	41	0.301
17	0.270	42	0.313
18	0.281	43	0.314
19	0.260	44	0.304
20	0.273	45	0.328
21	0.282	46	0.307
22	0.279	47	0.294
23	0.282	48	0.282
24	0.303	49	0.331
25	0.296	50	0.297

TABLE 2

Percentage of correct responses per item. Requisite Test for the Course MAT-111, 1978 version.

Item	(%)	Item	(%)
1	77,41	26	20,71
2	59,83	27	77,62
3	88,49	28	51,05
4	79,08	29	60,29
5	56,90	30	70,59
6	64,23	31	57,17
7	90,80	32	19,62
8	67,99	33	61,60
9	88,91	34	41,56
10	90,17	35	45,67
11	81,80	36	69,92
12	84,31	37	64,97
13	33,68	38	39,49
14	70,29	39	65,96
15	75,94	40	35,32
16	50,42	41	51,61
17	82,22	42	54,29
18	82,85	43	40,22
19	80,13	44	32,83
20	71,76	45	44,16
21	74,27	46	44,78
22	82,01	47	56,24
23	79,29	48	15,67
24	71,13	49	36,16
25	71,34	50	47,95

TABLE 3

Percentage of unanswered and incorrect responses (per distractor) in each item. Requisite Test for the Course MAT-111, 1978 version.

Item Nº	D_1 %	D_2 %	D_3 %	D_4 %	Error %	Omitted %
1	19.04	0.21	--	1.05	20.29	2.30
2	0.21	6.90	7.95	--	15.06	25.11
3	2.09	3.35	3.77	--	9.21	2.30
4	1.26	5.65	3.56	--	10.46	10.46
5	2.30	33.05	4.18	--	39.54	3.56
6	3.56	2.72	4.81	--	11.09	24.67
7	3.98	1.89	0.84	--	6.70	2.51
8	12.13	4.81	2.51	--	19.46	12.55
9	--	2.93	1.26	5.65	9.83	1.26
10	--	3.14	1.46	1.46	6.07	3.77
11	6.70	--	1.67	5.86	14.23	3.98
12	--	0.42	2.72	1.46	4.60	11.09
13	3.14	--	4.18	46.86	54.18	12.13
14	2.09	3.35	--	10.25	15.69	14.02
15	--	9.21	2.09	2.51	13.81	10.25
16	2.09	3.14	--	10.04	15.27	34.31
17	1.67	--	0.42	14.23	16.32	1.46
18	3.14	0.84	1.67	--	5.65	11.51
19	0.63	12.76	--	4.18	17.57	2.30
20	7.32	--	10.46	0.84	18.62	9.62
21	6.70	0.63	--	1.46	8.79	16.95
22	3.35	--	1.05	1.26	5.65	12.34
23	1.26	--	3.98	1.05	6.28	14.44
24	1.05	1.67	--	2.30	5.02	23.85
25	5.23	--	4.81	2.30	12.34	16.32
26	3.56	--	1.46	1.05	6.07	73.22

26	3.56	--	1.46	1.05	6.07	73.22
27	4.39	2.30	--	1.05	7.74	14.64
28	--	13.60	14.44	6.07	34.10	14.85
29	5.88	--	9.03	11.13	26.05	13.66
30	--	7.98	3.57	1.68	13.24	16.18
31	10.34	2.35	7.17	--	20.04	22.79
32	--	17.30	1.27	10.13	28.69	51.69
33	5.91	--	0.84	5.91	12.66	25.74
34	2.11	4.22	27.22	--	33.54	24.90
35	19.03	--	4.44	3.81	27.27	27.06
36	9.11	3.18	4.24	--	16.53	13.56
37	--	2.34	4.25	3.40	10.00	25.05
38	3.19	40.00	--	2.34	36.52	23.99
39	1.28	22.77	--	3.19	27.23	6.81
40	1.83	8.94	--	19.79	42.55	22.13
41	11.14	4.28	8.99	--	24.41	23.98
42	22.75	5.16	--	7.73	35.62	10.09
43	15.27	9.03	22.37	--	46.67	13.12
44	--	11.02	21.81	8.42	41.25	25.92
45	5.41	10.39	13.64	--	29.44	26.41
46	--	35.44	2.17	0.44	38.04	17.17
47	--	17.51	3.94	7.44	28.88	14.88
48	43.93	2.65	1.10	--	47.68	36.65
49	--	12.28	29.46	10.27	52.01	11.83
50	7.99	15.75	14.38	--	38.13	13.93

TABLE 4

Percentage of unanswered questions per item. Requisite Test for the Course MAT-111, 1978 version.

Percentage R.N.A.	Item
0.00	1 - 28
0.38	29 - 30
0.75	31 - 34
0.94	35
1.13	36
1.31	37 - 38
1.50	39 - 40
2.06	41
2.25	42
2.44	43
2.81	44
3.00	45
3.38	46
3.94	47
4.69	48
5.63	49
7.05	50